

Interactive comment on “Soil carbon estimates by Yasso15 model improved with state data assimilation” by Toni Viskari et al.

Anonymous Referee #2

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Referee #2 comments:

Review of "Soil carbon estimates by Yasso15 model improved with state data assimilation" by Viskari et al. 2020

General comments:

Viskari et al. applied the Ensemble Adjustment Kalman filter state data assimilation method (SDA) with soil carbon stock time series from six bare fallow experiments to improve the Yasso15 soil carbon model estimates. The application of SDA for the Yasso soil carbon model is unique and showed that the performance of the model improved already with few observations while model uncertainties decreased at least on three sites (Rothamsted, Grignon, Ultuna). Less improvement and higher uncertainties were

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found on the sites with higher decrease of late measurements than what could be expected by extrapolating early exponential decay trends. The analysis also showed that the estimates of humus pool could have declined more than predicted by default/no-SDA informed model while the more expectedly labile AWEN pools could have lately increased.

These were relevant findings of the study and were discussed mostly in relation to the method. However, the results of this study should be also discussed with similar studies applying Ensemble Kalman filter in the carbon modelling (Eg. Trundiner et al. 2008, Gao et al. 2011, Yan et al. 2019). For example analysis of parameters which was missing in this study in Gao et al. 2011 demonstrated that higher uncertainty of humus pool is correlated with poorly constrained exit rates to this pool.

The text should also be improved for clarity e.g. by separating ideas from lengthy sentences. Especially conclusions need reformulation e.g. large emphasis of conclusions included issues not studied by authors. Overall after the major text revision, the paper could be due to the interesting idea and unique results a valuable contribution to GMD journal and I could recommend it for publication.

Complying with the scope of GMD authors provided relatively clear code and simple tutorial. However, the analysis could not be easily replicated as some parts of the code are missing e.g. Yasso15 model function in R, and e.g. instructions of DART analysis (test bed for data assimilation) were in Finnish language. Please consider revising.

Specific comments:

- Title : Improving Yasso15 soil carbon model estimates with Ensemble Adjustment Kalman filter state data assimilation

- add short description of Ensemble Adjustment Kalman filter to introduction

L24 does the reference apply for peatlands and deforestation?

L44 remove repetition of future uncertainties

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L144-154 please reformulate, separate sentences

L173-176 please reformulate, separate sentences

L198-205 clarify by equation or method reference? mention error covariance matrix?

L220 add description of factors 1 and 1.25 included in the Fig. before describing not shown 1.5

L230 Although,...

L234 values (at Askov B4 after 1966, and at askov B3 after 1977).

L240 ... difference. However, ...

Results described in the main text but not shown in main figures could be shown in the supplement?

L255 replace close to each other by similar

L257 not clear, success of SDA forecast depends on inflation factors of error covariance matrix?

L265 delete one

L332 not clear

L335-339 please reformulate, increasing number of assimilated variables was not studied here

L339-341 please reformulate, why to estimate SOC in forest for agricultural C management

- check GMD format of references, add DOI numbers to references when available

References mentioned above:

Gao, C., Wang, H., Weng, E., Lakshmiarahan, S., Zhang, Y., & Luo, Y.: Assimilation of

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multiple data sets with the ensemble Kalman filter to improve forecasts of forest carbon dynamics. *Ecological Applications: A Publication of the Ecological Society of America*, 21(5), 1461–1473, <https://doi.org/10.1890/09-1234.1>, 2011.

Trudinger, C. M., Raupach, M. R., Rayner, P. J., & Enting, I. G.: Using the Kalman filter for parameter estimation in biogeochemical models. *Environmetrics*, 19(8), 849–870, <https://doi.org/10.1002/env.910>, 2008.

Yan, M., Li, Z., Tian, X., Zhang, L., & Zhou, Y.: Improved simulation of carbon and water fluxes by assimilating multi-layer soil temperature and moisture into process-based biogeochemical model. *Forest Ecosystems*, 6(1), 12, <https://doi.org/10.1186/s40663-019-0171-5>, 2019.

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2020-141>, 2020.

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